

# Educational outreach activities for Landsat-7

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## Abstract

The goal of the Landsat-7 educational program is to bring applications of Landsat data into K–16 classrooms. The educational strategy of the Landsat Science Team Office relies on collaborating with preexisting education programs in NASA's Earth Science Enterprise (ESE), as well as initiating new projects. Several current Landsat-based education products and programs are described that address science and geography education content for various grade levels. Current and future program developments using Landsat data are also identified for the K–16 classroom. © 2001 Elsevier Science Inc. All rights reserved.

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## 1. Introduction

An important component of NASA's Earth Science Enterprise (ESE) satellite programs is educational outreach. The Enterprise's goals for educational outreach are to: (1) expand the scientific knowledge of the earth system using NASA's unique vantage points of space, aircraft, and in situ platforms, (2) disseminate information about the earth system, and (3) enable the productive use of ESE science and technology in the public and private sectors (NASA, 1996). Landsat-7 is part of NASA's ESE program, a long-term coordinated research effort dedicated to studying how the global environment is changing. Landsat-7 is the latest in a series of satellites that have provided a continuous set of calibrated earth science data to users worldwide since the early 1970s. Landsat-7 continues the heritage of earlier Landsat programs by providing multi-spectral data at a 30-m spatial resolution on a global basis. In addition, a coregistered 15-m panchromatic band and a 60-m thermal band are available for more detailed analysis. Landsat-7 data are available at a reasonable cost, currently at

US\$600 per scene, which should allow for more widespread use of the image data for educational purposes.

In addition, several states are purchasing statewide data sets for use by educators within their state boundaries (see <http://gateway2earth.org/>). For example, the state of Ohio has purchased Landsat-7 data since July 1999 for the entire state of Ohio. These data sets are available for use by the educational and research communities. The model developed by Ohio is being followed by several other states, such as Texas, Mississippi, and Washington.

Since its launch in April 1999, Landsat-7 has been providing images of the land surface and surrounding coastal regions that are used in a wide range of earth system science applications, including monitoring global deforestation, estimating soil moisture, monitoring wildfire damage, and assessing land use change over time. The goal of the Landsat-7 education program is to bring these applications of Landsat-7 data (and Landsat data in general) to K–16 classrooms. To achieve this goal, the Landsat Project Science Office (LPSO) has developed an educational strategy that relies on collaboration with preexisting ESS education programs, as well as initiating new projects that take advantage of Landsat imagery.

In developing the Landsat-7 education strategy, the LPSO relied heavily on NASA's preexisting education infrastructure. There are six program categories that com-

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prise the NASA education program. These categories define the way that material is delivered to the formal and informal education communities (NASA, 1998). The six categories include the areas of research and technology, educational technology, student support, support of systemic change, curriculum support and dissemination, and teacher/faculty preparation and enhancement (NASA, 1998). Education programs developed for NASA should contain elements that fall into one or more of these categories. NASA also encourages educational product developers to utilize national education standards documents in geography, science, and mathematics education (i.e., Commission on Standards for School Mathematics, 1989; National Research Council, 1996; The Geography Education Standards Project, 1994). Curriculum developers normally use these three publications as they create, modify, and/or update state and local science, mathematics, and social science curricula at the K–12 grade level. Products that correlate with national standards are more likely to match state and local curricula and therefore are more likely to be used in the classroom.

The ESE reviews earth science-related education products produced by teachers and researchers, and conducts an annual workshop for NASA educators. Materials are reviewed by scientists and educators for content (accuracy, relevance to ESE missions, and congruent with national content standards) and pedagogy (congruent with national teaching standards). The ESE annual education workshop features the products that pass the ESE review. These products are then disseminated to classroom teachers through local NASA education workshops.

In summary, the goal of the LPSO is to develop Landsat products that are flexible enough to satisfy the requirements of the educational community.

## **2. The education strategy of the Landsat-7 Project Science Office**

The key components of the Landsat-7 education strategy for the Landsat-7 Project Science Office (LPSO) are to: (1) identify current Landsat-based education products and programs that can be used to teach ESS content at various grade levels, (2) coordinate these programs to provide Landsat-7 data to enhance existing education projects, (3) identify and target new program development in the K–16 areas (either by content and/or grade level), and (4) create a training and dissemination network through NASA and other ESS organizations. The reader is encouraged to contact the authors for more details about this strategy and the status of its implementation.

### *2.1. Identifying current products*

There are a number of current education products and programs that use Landsat and other remote sensing data to teach science and geography content. We first identified

Landsat-based products that have been evaluated and recommended for distribution in NASA's ESE annual education product review. Education products in the ESE review are evaluated on the basis of sound pedagogy, grade level appropriateness, and scientific content by a panel of educators and scientists. The ESE-recommended Landsat-related products include two web sites that integrate Landsat data into a series of lessons and activities and two sites that are essentially online textbooks. These products are highlighted on the LPSO Landsat-7 web site (see <http://landsat.gsfc.nasa.gov/main/education.html>) and are further described in the ESE-reviewed education products section. The Education page also has links to other Landsat-based materials that teachers may find useful in the classroom. Each link also includes a brief description and the recommended grade level for the product.

### *2.2. Providing Landsat-7 data*

The LPSO is exploring several approaches to provide Landsat-7 data to existing education programs and projects. The LPSO plans to create an archive for educators using Landsat data purchased by LPSO and is currently in development. The Landsat-7 science team members will be contributing several of their data sets to the archive. We are in the process of surveying educators and product developers to identify data and image formats that are easily adaptable for classroom use.

One large environmental education program that uses image processing tools and Landsat data is Global Learning and Observations to Benefit the Environment (GLOBE). GLOBE is a hands-on, school-based international environmental science and education program involving students in over 8000 primary and secondary schools in 80 countries. GLOBE students make environmental observations at or near their schools and report their data through the Internet. Educators that want to become part of GLOBE should contact the GLOBE headquarters (<http://www.globe.gov/>). Scientists use GLOBE data in their research and provide feedback to the students to enrich their science education. Each GLOBE school receives a  $512 \times 512$  pixel Landsat-5 Thematic Mapper (TM) scene centered on their school. Using Multispec software (available from Purdue University, see <http://dynamo.ecn.purdue.edu/~biehl/MultiSpec/>), GLOBE students map land cover using an unsupervised cluster analysis of their Landsat-5 TM scene, as part of the Land Cover/Biology Investigation (see the land cover/biology protocols in the Measurements section at <http://www.globe.gov/>). The LPSO is working with GLOBE to provide Landsat-7 scenes for those GLOBE schools that have completed their Landsat-5 land cover measurements and reported the data over the Internet. We have also created a multidisciplinary education module that links to GLOBE and makes use of Multispec and both Landsat-5 and Landsat-7  $512 \times 512$  scenes. This project is further described in the Multidisciplinary unit on remote sensing section.

### 2.3. Identify and target new programs

Through our survey of Landsat-based education products and programs, we found a range of materials aimed at middle and high school students. Very few Landsat remote sensing education products were found to be appropriate for elementary students. In response to this, the LPSO has added support to several projects for younger students, including a picture book on remote sensing (see *Echo the Bat Pop Up Book*, NASA, 2001), a poster (Echo the Bat Poster), and an ESE-funded web site with lessons on remote sensing for K–4 students (see *The Adventures of Amelia the Pigeon*).

On the content side, the LPSO is working with the Goddard Space Flight Center (GSFC) Education office to map Landsat-7 applications to National Science Education Standards and National Geography Education Standards. We are providing standards-based content materials for use in a new high school Earth System Science course that has been adopted by one Maryland county and is being considered for adoption by several other counties.

### 2.4. Training and dissemination

Our training and dissemination strategy is designed to capitalize on the NASA education infrastructure and the links between NASA educators and other organizations that support teacher enhancement programs. Specifically, we are developing a training model for “training the trainers” — these are NASA educators who conduct teacher workshops nationwide. The pilot workshop (to be held Spring 2001) for the GSFC education staff will emphasize the fundamentals of remote sensing with applications of Landsat data. A guide to train teachers in the use of Landsat-based education products is under development. These trainers will conduct workshops both for teachers and for other NASA educators. The trainers shall be responsible for follow-up contact with workshop participants to determine if and how materials are implemented in the classroom. The results of follow-up contact will provide information to make decisions on additional product training and dissemination.

A second round of training workshops will target organizations outside of NASA that conduct teacher workshops. We plan to create training product modules tailored to the goals of the individual organization. For example, training modules created for the GLOBE program could emphasize products that focus on the use of Landsat data for land cover/land use investigations. One such workshop is being planned that combines GLOBE measurements with Landsat data on a project to study the Chesapeake Bay Watershed.

## 3. Examples from the Landsat-7 education program

Details of the Landsat-7 educational outreach activities are described in further detail in this section. With the

changing nature of these activities, the web sites are continuously updated, so we encourage you to check these sites frequently.

### 3.1. LPSO education projects

#### 3.1.1. Landsat-7 teacher's kit

A web site on Landsat-7 — A Global View of the Earth — is designed principally for use by middle school teachers (for Grades 5–8) to provide them with curriculum materials for teaching changes on the Earth using Landsat data (see <http://ltpwww.gsfc.nasa.gov/landsat7/teacherkit/index.html>). The activities are presently illustrated with Landsat TM data, but will be supplemented for use with the Enhanced Thematic Mapper Plus (ETM+) data. Current lessons are focused on a description of the Landsat-7 satellite, the Landsat orbit, and the use of Landsat images for various earth applications. In addition, a unit on using an ALTA reflectance spectrometer (available from Universities Space Research Association, Lunar and Planetary Institute, Houston, TX 77058-1113, USA) for measuring the reflectance of ground materials is included.

Landsat applications will be focused on agriculture, forestry and range resources, land use/land cover mapping, geology, water resources, coastal resources, and the environment. The classroom materials on the web site are structured according to the five E's constructivist model — engagement, exploration, explanation, extension, and evaluation. This model structure allows for an inquiry-based approach for the use of Landsat data in a particular topic area and allows teachers to alter the lessons according to their students' level. Lesson plans, worksheets, glossary of terms, standards, and a list of resources to enhance the lessons are provided.

#### 3.1.2. Multidisciplinary unit on remote sensing

An interdisciplinary education project for studying urban sprawl and land cover change — How Can We Grow Smarter? — was developed for a middle school in suburban Maryland, just outside of Washington, DC (F. Niepold, 1999, personal communication). Science, mathematics, geography, and English teachers worked together to plan the project. In a role-playing exercise, students represented different constituencies confronting the issues of population and development growth in their county. The middle school students interviewed members of the community to better understand their roles in a mock town meeting addressing the issue of land use change. Students used a variety of data sets, including aerial photographs, topographic maps, and Landsat data to investigate land use change over time in the area around their school. Using MultiSpec software and Landsat images provided by the GLOBE program and LPSO, the students produced  $\Delta NDVI$  (Normalized Difference Vegetation Index) images that highlighted areas of change.

The lesson modules, data sets, and Multispec tutorials will be available on the LPSO education web site (see <http://ltpwww.gsfc.nasa.gov/landsat7/>) in Summer 2001. Following beta testing and revisions, the multidisciplinary unit will be submitted to the ESE Education Review Panel.

### 3.2. *The Adventures of Amelia the Pigeon*

The LPSO is providing Landsat-7 data, science reviewers, and field testing support to a K–4 education project funded by an ESE education grant (NRA-99-OES-02). The *Adventures of Amelia the Pigeon* engages children in studying change in urban and natural landscapes. These changes are illustrated through historical maps, bird's-eye view drawings, aerial photography, and satellite imagery of parks and other habitats in the urban environment. Children see how land use, city planning, and environmental changes affect their habitat. The interactive web site and classroom activities encourage children to look at their own world from different perspectives. *Amelia the Pigeon* ties historical events with visible change in the urban landscape. Students learn how this unique view helps us study man and nature's impact on our changing environment. Field-testing of the program begins in Spring 2001.

### 3.3. *ESE-reviewed education products*

#### 3.3.1. *Echo the Bat*

"Imagers, The Adventure of Echo the Bat" is a web site built around an interactive adventure that brings together curriculum content related to biodiversity, ecology, remote sensing, and the electromagnetic spectrum for Grades 5–8 (see <http://imagers.gsfc.nasa.gov>). NASA and the U.S. Geological Survey — Biological Research Division, provided funding for this program. The classroom activities are designed to introduce concepts basic to the understanding of remote sensing for middle school students. The site includes a Teachers Guide that contains classroom activities and lesson plans that provide a structure to integrate the interactive adventure into the classroom.

#### 3.3.2. *Classroom of the future: exploring the environment*

"Exploring the Environment" uses 17 web-based learning modules (for Grades 9–12) that address real environmental dilemmas worldwide (see <http://www.cotf.edu/products/main.html>). Using imaging software, students observe chemical, biological, and geologic changes by working with remote sensing data sets. Working in teams like real scientists, students are challenged to track a live hurricane, predict the global impact of a volcanic eruption, investigate the shrinking habitat of the mountain gorillas in Rwanda, and examine issues and images of the Amazon rain forest.

#### 3.3.3. *Geomorphology from space*

The "Geomorphology from Space" web site is an online version of an out-of-print 1986 NASA publication (Short & Blair, 1986) designed for use by the remote sensing science

and educational communities for Grades 9–12 to study landforms and landscapes (see [http://daac.gsfc.nasa.gov/DAAC\\_DOCS/geomorphology/GEO\\_HOME\\_PAGE.html](http://daac.gsfc.nasa.gov/DAAC_DOCS/geomorphology/GEO_HOME_PAGE.html)). Space imagery is arranged by geomorphic theme, i.e., tectonic (structural), volcanic, fluvial, delta, coastal, karst and lakes, eolian, glacial, and planetary landforms. The bulk of the images are from Landsat instruments, including the Multispectral Scanner on Landsat-1, -2, and -3, the Return Beam Vidicon on Landsat-3, and the TM on Landsat-4 and -5.

#### 3.3.4. *The remote sensing tutorial*

The "Remote Sensing Tutorial" is a comprehensive online remote sensing tutorial for the undergraduate (or general interest) level student (see <http://rst.gsfc.nasa.gov>). This educational web site for the undergraduate level is also an excellent reference for anyone ready to explore fundamentals and applications of remote sensing.

## 4. Conclusions

In conclusion, we believe that Landsat-7 data will be extensively used in the classroom, particularly at the K–16 level. The existing and future funded education projects being developed under NASA's ESE program will promote the understanding of earth system science for future generations. Additional educational materials are still being developed and tested. We encourage you to contact the authors and/or the web sites listed in this paper for updates. In addition, several members of the Landsat-7 Science Team [e.g., Luke Flynn (University of Hawaii) and Susan Moran (U.S. Department of Agriculture)] have developed educational materials related to their Landsat-7 research activities.

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